TITLE OF THE INVENTION

PATTERN CORRECTING METHOD OF MASK FOR MANUFACTURING
A SEMICONDUCTOR DEVICE AND RECORDING MEDIUM HAVING
RECORDED ITS PATTERN CORRECTING METHOD

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based upon and claims the
benefit of priority from the prior Japanese Patent
Application No. 11-260270, filed September 14, 1999,
the entire contents of which are incorporated herein by
reference.

BACKGROUND OF THE INVENTION

The present invention relates to a pattern
correcting method of a mask for exposure used in a
lithography process in manufacturing a semiconductor
device, mask pattern correcting device and the mask for
exposure and the semiconductor device using them.

Recently, with segmentation of a semiconductor
device, problems have been arising that finished
dimension is not exactly as designed in some portions.
An example is shortening of a line end part. An
example of the shortening is shown in FIG. 1.

Causes of the shortening can be as follows:

(1) Masks are not manufactured according to
design dimension;

(2) Corner portions of a line end is already the
light resolution limit; and

(3) Mask conversion difference caused by etching.

Taking a wiring pattern of a borderless contact as an example, when a line end where contact portions overlap each other is shortened, an area of contact between the line and a contact hole is reduced, which

5 causes rise in via resistance. This is one of the causes deteriorating device performance.

In order to avoid adverse effect by such shortening, methods such as designing with some additional fringe amount in advance for the contact

10 portion or uniformly providing a fringe amount estimated by experiments using a correcting tool have been commonly used.

However, finishing error in shortening amount or the like can be varied depending on pattern density or

15 line width.

In this way, in the conventional mask pattern correcting method, pattern dependency of the finishing error is not considered and sufficient correcting accuracy can not be obtained.

20 BRIEF SUMMARY OF THE INVENTION

The present invention has been made in consideration of the above circumstances, and its objective is to provide a pattern correcting method of a mask for manufacturing a semiconductor device that

25 can obtain sufficient correction accuracy.

In order to achieve the objective, a pattern correcting method of a mask for manufacturing a

semiconductor device comprising:

With the pattern correcting method of a mask for manufacturing a semiconductor device having the above constitution,

5   (1) As this method considers the relationship between a variation amount in line width of a line portion generated after wafer process and a space width from the portion where the line portion overlaps a contact portion to the portion another line portion

10   adjoining this overlapped portion, that is, the environment around the pattern to be corrected is considered, sufficient correction accuracy can be obtained in comparison with a correcting method not considering the surrounding environment.

15   In connection with the surrounding environment, following environments can be considered:

(2) Relationship between a shortening amount of the line portion generated after the wafer process and the space width from the portion where the line portion

20   overlaps the contact portion to another line portion adjoining this overlapped portion.

(3) Relationship between the shortening amount of the line portion generated after the wafer process and an area in a end portion of the line portion running

25   across a transistor portion which is a gate end and not on the transistor portion.

(4) Relationship between a rounding amount on the

transistor portion generated after the wafer process and the line portion.

(5) Relationship between the dimension of the line portion and a diameter difference between a first contact portion where the contact portion generated after the wafer process makes a contact with the transistor portion and a second contact portion where the contact portion makes a contact with the line portion.

(6) Relationship between the shortening amount of the line portion generated after the wafer process and the distance from the area where the line portion overlaps the contact portion to the end of the line portion.

(7) Relationship between the correction amount and the space width between one transistor portion and another adjoining transistor portion, if an enlarged contact portion adjoins one transistor portion or not.

Additional objects and advantages of the invention will be set forth in the description which follows, and in part will be obvious from the description, or may be learned by practice of the invention. The objects and advantages of the invention may be realized and obtained by means of the instrumentalities and combinations particularly pointed out hereinafter.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

The accompanying drawings, which are incorporated

in and constitute a part of the specification, illustrate presently preferred embodiments of the invention, and together with the general description given above and the detailed description of the preferred embodiments given below, serve to explain the principles of the invention.

FIG. 1 is a diagram for explaining shortening.

FIG. 2 is a flowchart showing a mask pattern correcting method according to a first preferred embodiment of the present invention.

FIG. 3A is a plan view showing a pattern example used for the first preferred embodiment of the present invention.

FIG. 3B is a plan view showing a pattern example used for the first preferred embodiment of the present invention.

FIG. 3C is a plan view showing a measurement pattern example used for the first preferred embodiment of the present invention.

FIG. 3D is a diagram showing relationship between a space width and a line width variation amount.

FIG. 3E is a diagram showing relationship between a space width and a line width variation amount.

FIG. 3F is a table showing a correction rule.

FIG. 3G is a plan view showing a pattern example used for the first preferred embodiment of the present invention.

FIG. 4 is a flowchart showing a mask pattern correcting method according to a second preferred embodiment of the present invention.

FIG. 5A is a plan view showing a pattern example used for the second preferred embodiment of the present invention.

FIG. 5B is a plan view showing a pattern example used for the second preferred embodiment of the present invention.

FIG. 5C is a plan view showing a measurement pattern example used for the second preferred embodiment of the present invention.

FIG. 5D is a diagram showing a space width and a shortening amount.

FIG. 5E is a diagram showing a space width and a shortening amount.

FIG. 5F is a table showing a correction rule.

FIG. 5G is a plan view showing a pattern example used for the second preferred embodiment of the present invention.

FIG. 6 is a flowchart showing a mask pattern correcting method according to a third preferred embodiment of the present invention.

FIG. 7A is a plan view showing a pattern example used for the third preferred embodiment of the present invention.

FIG. 7B is a plan view showing a pattern example

used for the third preferred embodiment of the present invention.

FIG. 7C is a plan view showing a pattern example used for the third preferred embodiment of the present invention.

FIG. 7D is a plan view showing a measurement pattern example used for the third preferred embodiment of the present invention.

FIG. 7E is a diagram showing a space width and a shortening amount.

FIG. 7F is a diagram showing a space width and a shortening amount.

FIG. 7G is a table showing a correction rule.

FIG. 7H is a plan view showing a pattern example used for the third preferred embodiment of the present invention.

FIG. 8 is a is a plan view showing a mask pattern correcting method according to a fourth preferred embodiment of the present invention.

FIG. 9A is a plan view showing a pattern example used for the fourth preferred embodiment of the present invention.

FIG. 9B is a diagram showing relationship between an area and a shortening amount.

FIG. 9C is a diagram showing relationship between an area and a shortening amount.

FIG. 9D is a table showing a correction rule.

FIG. 9E is a plan view showing a pattern example used for the fourth preferred embodiment of the present invention.

FIG. 10 is a flowchart showing a mask pattern correcting method according to a fifth preferred embodiment of the present invention.

FIG. 11A is a plan view showing a pattern example used for the fifth preferred embodiment of the present invention.

FIG. 11B is a plan view showing a pattern example used for the fifth preferred embodiment of the present invention.

FIG. 11C is a table showing a correction rule.

FIG. 11D is a plan view showing a notched portion.

FIG. 11E is a plan view showing a notched portion.

FIG. 11F is a plan view showing a notched portion.

FIG. 12 is a flowchart showing a mask pattern correcting method according to a sixth preferred embodiment of the present invention.

FIG. 13A is a sectional view showing a pattern example used for the sixth preferred embodiment of the present invention.

FIG. 13B is a diagram showing relationship between a design dimension and a diameter difference.

FIG. 13C is a diagram showing relationship between a design dimension and a diameter difference.

FIG. 13D is a table showing a correction rule.

FIG. 13E is a table showing a correction rule.

FIG. 13F is a sectional view showing a pattern example used for the sixth preferred embodiment of the present invention.

5 FIG. 13G is a sectional view showing a pattern example used for the sixth preferred embodiment of the present invention.

FIG. 14 is a flowchart showing a mask pattern correcting method according to a seventh preferred 10 embodiment of the present invention.

FIG. 15A is a sectional view showing a pattern example used for the seventh preferred embodiment of the present invention.

FIG. 15B is a diagram showing relationship between 15 a shortening amount and a space width.

FIG. 15C is a diagram showing relationship between a shortening amount and a space width.

FIG. 15D is a table showing a correction rule.

FIG. 15E is a diagram showing relationship between 20 a shortening amount and a space width.

FIG. 15F is a diagram showing relationship between a shortening amount and a space width.

FIG. 15G is a table showing a correction rule.

FIG. 15H is a sectional view showing a pattern 25 example used for the seventh preferred embodiment of the present invention.

FIG. 16 is a flowchart showing a mask pattern

correcting method according to a eighth preferred

embodiment of the present invention.

FIG. 17A is a table showing a correction rule.

FIG. 17B is a table showing a correction rule.

5   FIG. 17C is a table showing a correction rule.

FIG. 18 is a flowchart showing a mask pattern

correcting method according to a ninth preferred

embodiment of the present invention.

FIG. 19A is a plan view showing a pattern example

10   used for the ninth preferred embodiment of the present

invention.

FIG. 19B is a plan view showing another pattern

example used for the ninth preferred embodiment of the

present invention.

15   FIG. 19C is a diagram showing relationship between

a correction amount and a space width.

FIG. 19D is a table showing a correction rule.

FIG. 19E is a plan view showing a pattern example

used for the ninth preferred embodiment of the present

20   invention.

FIG. 19F is a plan view showing another pattern

example used for the ninth preferred embodiment of the

present invention.

DETAILED DESCRIPTION OF THE INVENTION

25   Preferred embodiments of the present invention

will be described below referring to the drawings.

In the description, common parts shall bear common

reference numbers through the drawings.

(First preferred embodiment)

First, a mask pattern correcting method according to a first preferred embodiment of the present invention will be explained.

The first preferred embodiment shows fringe processing of correcting and changing a pattern in a portion overlapping a contact portion in a wiring pattern having a borderless contact (line portion) by considering and correcting density of the pattern around the portion and the line width of the line portion.

FIG. 2 is a flowchart showing a mask pattern correcting method according to the first preferred embodiment, and FIGS. 3A to 3G are diagrams for explaining steps shown in FIG. 2.

At the Step ST.1 shown in FIG. 2, a portion where the line portion overlaps the contact portion is extracted.

FIG. 3A shows an example of a pattern having the line portion, contact portion and their overlapped portion used for the first preferred embodiment. The example shown in FIG. 3A is the one on design, for example, on CAD data. As shown in FIG. 3A, the pattern according to the example has line portions 1, 2, 3-1, and 3-2 in parallel with each other. The line portions 3-1 and 3-2 are arranged between the line

portion 1 and the line portion 2, respectively.
The contact portion 4-1 overlaps the end of the line
portion 3-1. Also, the contact portion 4-2 overlaps
the middle of the line portion 3-2 but not its end.

5   Then, at the Step ST.2, a space width between the
above overlapped portion and the adjoining line portion
is extracted on design, for example, on CAD data.

Here, for the above space width, in the case of
the contact portion 4-1 overlapping the end of the line
10   portion as shown in FIG. 3B, the space width to the
line portion opposed to each of the three sides of the
overlapped portion is extracted. In the meantime, wen
only the middle part of the line portion is overlapped
as the contact portion 4-2, the space width to the line
15   portion opposed to each of the two sides of the
overlapped portion is extracted.

In the pattern according to the above example, a
space width S1 from the contact portion 4-1 to the line
portion 1, a space width S2 from the contact portion 4-
20   1 to the line portion 3-2 and a space width S3 from the
contact portion 4-1 to the line portion 2 were measured
on design and extracted. And a space width S4 from the
contact portion 4-2 to the line portion 1 and a space
width S5 from the contact portion 4-2 to the line
25   portion 3-2 are measured on design and extracted.

Moreover, at the Step ST.2, in addition to the
space widths S1 through S5, the line width of the line

portion is extracted.

In the pattern according to the above example, a line width L of the line portion 3-1 overlapping the contact portion 4-1 was measured on design and

5   extracted. The line width L of the line portion 3-1 is equal to the line width of the line portion 3-2.

Next, at the Step ST.3, relationship between the space width and the line width variation amount is obtained experimentally or by simulation. When this

10   relationship is obtained experimentally, a line width variation amount may be measured by creating a measurement pattern with the line and space (L/S) pattern as shown in FIG. 3C on a wafer and by using this with scanning electron microscope (SEM) or

15   electric measurement. When obtained by simulation, a measurement pattern as shown in FIG. 3C is reproduced by a manufacturing process simulator, and its line width variation amount may be calculated. Examples of the obtained relationship between the space width and

20   the line width variation amount are shown in FIGS. 3D and 3E.

Next, at the Step ST.4, using the obtained relationship between the space width and the line width variation amount, a correction rule for the space width

25   to the adjoining line portion is established. The correction rule is set as follows, for example.

As shown in FIGS. 3D and 3E, the line width

variation amount is divided per design grid width W.
The design grid width W is the minimum width that can
be add at one time on CAD, for example. Then,
intersections "a," "b," and "c" between the design

5   grid width W and a variation curve I are extracted.
Then, the space width S is divided per intersection
parts, "S < a," "a $\leq$ S < b," "b $\leq$ S < c ," and
"c $\leq$ S."

In this example, as shown by the variation

10   curve I, the larger becomes the space width S, the
greater is dislocated the line width variation amount
from "0" (line width design value). That is, the
larger becomes the space width S", the thinner becomes
the line width L

15   Based on such trends, in the first preferred
embodiment, a correction rule is set so that as the
space width S gets larger compared to the above
overlapped portion, the width of the above overlapped
portion becomes larger. In this example, a correction

20   value is set at "0" for the range of the space width S
of "S < a," the correction value being set at "+W"
for the range of "a $\leq$ S < b," the correction value
being set at "+2W" for the range of "b $\leq$ S < c," and
the correction value being set at "+3W" for the range

25   of "c $\leq$ S."

Then, at the Step ST.5, according to the above
correction rule, a correction rule table as shown in

FIG. 3F is made. After that, the space widths S1, S2, S3, S4, and S5 are checked with the established correction rule table and an appropriate correction value is extracted.

5   Then, at the Step ST.6, the extracted correction value is added to the line end of the portion where the line portion overlaps the contact portion as a fringe amount. Such fringe processing can be automatically executed by making a correction tool adapted to

10   the present invention through programming, storing it in CAD, for example, and using it appropriately. A pattern according to the example of the state where the fringe processing is completed is shown in FIG. 3G. As shown in FIG. 3G, the above overlapped portion is

15   provided respectively with fringes 5-1 and 5-2.

     In this way, according to the first preferred embodiment, a correction value (fringe amount in this example) considering the surrounding environment such as pattern density, its line width, etc., is obtained

20   for the portion where the line portion overlaps the contact portion, and the obtained correction values are compiled into a correction rule table. After that, fringe processing is executed automatically using the correction tool according to the correction rule table.

25   In a pattern made using a mask for manufacturing a semiconductor device to which such fringe processing is given, in comparison to the case where a mask is

used to which a uniform fringe processing is given
regardless of the surrounding environment, the above
overlapped portion can be finished in the state closer
to the design value or according to the design value.

5   As the above overlapped portion can be finished in
the state closer to the design value, a problem such as
a rise in contact resistance caused by reduction in
a contact area or the like, for example, can be
avoided. Thus, in a formed integrated circuit,

10   a contact resistance closer to the design value can be
obtained, and expected electric performance can be
gained easily on circuits.

         The difference between an example (FIG. 3D) and
another example (FIG. 3E) of the correction rule is

15   that the correction value is incremented by "W" with
the line width variation amount "0" as reference or
that the correction value is incremented by "W" with
the value of the line width variation amount "0" plus
1/2 of the design grid width W as reference. In either

20   example, a pattern formed on the wafer can be finished
in the state close to the design value or according to
the design value.

         However, another example that the correction value
is incremented by "+W" with the value plus 1/2 of the

25   design grid width as reference shown in FIG. 3E is
finished much closer to the design value or according
to the design value.

That is because in one example shown in FIG. 3D, the variation of the line width L can be kept to the variation within the range from the line width variation amount "0" (that is, design value) to "-W," while another example shown in FIG. 3E can further keep the variation to the range from the line width variation amount "0" (that is, design value) to the range of "±W/2."

Also, as shown in FIG. 3G, in the pattern according to the above one example, correction is made so that the fringes 5-1 and 5-2 are added to the line portions 3-1 and 3-2 with the line width L but when there is a line width other than the line width L, a correction rule is established in the same way as above for each line width, and a correction rule table is made according to this correction rule. After that, correction can be made by adding fringes based on the established correction rule table.

(Second preferred embodiment)

Next, a mask pattern correcting method according to a second preferred embodiment of the present invention.

The second preferred embodiment is, as with the first preferred embodiment, fringe processing of correcting and changing the pattern in the portion overlapped with the contact portion, considering pattern density around the portion and the line width

of the line portion in the wiring pattern having a borderless contact (line portion). The difference is that in the first preferred embodiment, the correction rule was established based on the relationship between

5 the line width variation amount and the space width, while in the second preferred embodiment, the correction rule is made based on the relationship between the shortening amount and the space width in the line portion.

10 FIG. 4 is a flowchart showing a mask pattern correcting method according to the second preferred embodiment, and FIGS. 5A to 5G are diagrams for explaining steps shown in FIG. 4.

At the Step ST.1 shown in FIG. 4, the portion

15 where the line portion overlaps the contact portion is extracted. An example of the pattern used for the second preferred embodiment is shown in FIG. 5A. The example shown in FIG. 5A is on design, for example, on CAD design, which is a pattern similar to the example

20 shown in FIG. 3A.

Then, at the Step ST.2, the space width (distance) between the above overlapped portion and the adjoining line portion is extracted on design, for example, on CAD data.

25 Here, for the above space width, as with the first preferred embodiment, the space width S1 from the contact portion 4-1 to the line part 1, the space

width S2 from the contact portion 4-1 to the line

portion 3-2, the space width S3 form the contact

portion 4-1 to the line portion 2, the space width S4

from the contact portion 4-2 to the line portion 1, and

5   the space width S5 from the contact portion 4-2 to the

line portion 2 were measured and extracted on the

design.

Moreover, at the Step ST.2, the line width of the

line portion is extracted together with the space

10   widths S1 to S5. Here, as with the first preferred

embodiment, the line width L where the contact portion

4-1 overlaps the line portion 3-1 was measured on the

design and extracted. The line width L of the line

portion 3-1 and the line width of the line width 3-2

15   are supposed to be equal.

Then, at the Step ST.3, the relationship between

the space width and the shortening amount of the line

portion is obtained experimentally or by simulation.

When this relationship is obtained experimentally, a

20   measurement pattern with a pattern shown in FIG. 5C is

formed on a wafer, and a shortening amount can be

measured using a scanning electron microscope (SEM) or

electric measurement. When obtained by simulation, a

measurement pattern shown in FIG. 5C is reproduced on

25   a manufacturing process simulator to calculate the

shortening amount.

Then, at the Step ST.4, a correction rule is

established for the space width to the adjoining line
portion using the obtained space width and the
shortening amount. The relationship between the space
width and the shortening amount is shown in FIGS. 5D
5   and 5E.

As shown in FIGS. 5D and 5E, the greater becomes
the space width S, the larger is dislocated the
shortening amount from "0", that is, the design value
(variation curve I). That is, the greater becomes the
10   space width S the thinner becomes the line width L.
Based on such trends, in the second preferred
embodiment, a correction rule to correct a pattern is
established so that the width of the above overlapped
portion gets larger as the space width S becomes larger
15   compared to the above overlapped portion. ·

Then, at the Step ST.5, a correction rule table is
made based on the above correction rule. To do this,
as shown in FIGS. 5D and 5E, the vertical axis
(shortening amount) is first divided per design
20   grid width W (the design grid width W is, for example,
the minimum width which can be added at one time
on CAD). Next, an intersection between the design
grid width W and the variation curve I is extracted.
The intersections obtained through this work are "a,"
25   "b," and "c." Then, the correction value is set at "0"
for the range of the space width S of "S < a," while
the correction value of "+W" is provided for the range

of the space width S of "a $\leq$ S < b." Moreover, the
correction value of "+2W" is provided for the range
of the space width S of "b $\leq$ S < c," and the
correction value of "+3W" for the range of the space
width S of "c $\leq$ S." By this work, a correction rule
table as shown in FIG. 5F is made.

Moreover, at the Step ST.5, correction values for
the space widths S1, S2, S3, S4, and S5 obtained at the
Step ST.2 are extracted from the correction rule table
so made.

Then, at the Step ST.6, the extracted correction
values are added as a fringe amount to the line end of
the portion where the line portion overlaps the contact
portion. This fringe processing can be automatically
executed by making a correction tool adapted to the
present invention through programming, storing it
in CAD, for example, and using it appropriately.
A pattern example of the state where the fringe
processing is completed is shown in FIG. 5G. As shown
in FIG. 5G, the above overlapped portion is provided
respectively with fringes 5-1 and 5-2.

According to the second preferred embodiment, as
with the first preferred embodiment, a correction
fringe amount is obtained considering the surrounding
environment such as pattern density, its line width,
etc. for the portion where the line portion overlaps
the contact portion, and the obtained correction fringe

amounts are made into a correction rule table. After
that, fringe processing is executed automatically using
the correction tool according to the correction rule
table.

5   In a pattern formed by a wafer process using a
mask for manufacturing semiconductor to which such
fringe processing is given, the above overlapped
portion can be finished in the state closer to the
design value or according to the design value in

10   comparison to the case where a mask to which uniform
fringe processing is given regardless of the
surrounding environment.

In this way, as the above overlapped portion can
be finished in the state closer to the design value, a

15   problem such as a rise in contact resistance caused by
reduction in a contact area or the like, for example,
can be avoided. Thus, in a formed integrated circuit,
a contact resistance closer to the design value can be
obtained, and expected electric performance can be

20   gained easily on circuits.

The difference between an example (FIG. 5D) and
another example (FIG. 5E) of the correction rule is
that the correction value is incremented by "W" with
the shortening amount "0" as reference or that the

25   correction value is incremented by "W" with the value
of the shortening amount "0" plus 1/2 of the design
grid width W as reference. In either example,

a pattern formed on the wafer can be finished in the state close to the design value or according to the design value.

However, another example that the correction value is incremented by "+W" with the value plus 1/2 of the design grid width as reference shown in FIG. 5E is finished much closer to the design value or according to the design value.

That is because in one example shown in FIG. 5D, the variation of the line width L can be kept to the variation within the range from the shortening amount "0" (that is, design value) to "-W", while another example shown in FIG. 5E can further keep the variation to the range from the line width variation amount "0" (that is, design value) to the range of "$\pm W/2$."

Also, as shown in FIG. 5G, in the pattern according to the above one example, correction is made so that the fringes 5-1 and 5-2 are added to the line portions 3-1 and 3-2 with the line width L but when there is a line width other than the line width L, a correction rule is established in the same way as above for each line width, and a correction rule table is made according to this correction rule. After that, correction can be made by adding fringes based on the established correction rule table.

In addition, both the first and the second preferred embodiments can be applied to one pattern

example. In this case, the second preferred embodiment is applied to the line space S2 where the short sides of the line portion are opposed to each other, while the first preferred embodiment is applied to the space width S1, S3, S4 and S5 where the long sides of the line portion are opposed to each other.

The reason for this is that it is desirable to make correction based on the relationship between the space width and the shortening amount since shortening can easily occur for the space width where the short sides of the line portion are opposed to each other. Similarly, for the space width where the long sides of the line portion are opposed to each other, it is desirable to make correction based on the relationship between the space width and the line width variation since line width variation (thinning of wiring) can be easily occur.

(Third preferred embodiment)

Next, a mask pattern correcting method according to the third preferred embodiment of the present invention will be described. Unlike the first and the second preferred embodiments, this is fringe processing for correcting and changing the pattern of the contact portion and the overlapped portion, considering the pattern density of the surrounding area and the line width of the line portion in the wiring pattern (line portion) having a bordered contact.

FIG. 6 is a flowchart showing a mask pattern correcting method according to the third preferred embodiment, FIGS. 7A through 7H are diagrams for explaining steps shown in FIG. 6.

5   First, at the Step ST.1, a portion where the line portion overlaps the contact portion is extracted. FIG. 7A shows an example of the pattern used for the third preferred embodiment. The example shown in FIG. 7A is on design, for example, on CAD data.

10   As shown in FIG. 7A, the pattern according to the example has line portions1, 2, 3-1 and 3-2 in parallel with each other. The line portions 3-1 and 3-2 are arranged between the line portion 1 and the line potion 2, respectively. The contact portion 4 overlaps the

15   contact portion 3-c provided at the end of the line portion 3-1.

Then, at the Step ST.2, as shown in FIG. 7B, the contact portion 4 is enlarged by the minimum design rule portion. A dotted line 6 shows the enlarged

20   contact portion.

Moreover, at the Step ST.2, the side where the enlarged contact potion 6 is in contact with the line end of the line portion 3 is extracted.

In the pattern according to the above example, the

25   above side in contact is a side 7 opposing the line portion 3-2 in the contact potion 3-c.

Then, at the Step ST.3, the space width (distance)

between the above side 7 in contact and the adjoining

line portion is extracted on design, for example, on

CAD data.

Here, for the above space width, the space width S

5   from the side 7 in contact to the line portion 3-2 was

measured and extracted on the design.

In addition, at the Step ST. 3, the line width of

the line portion as well as the space width S are

extracted. Here, as with the first preferred

10   embodiment, the line width L of the line portion 3-1

overlapping the contact portion 4 was measured on the

design and extracted (The line width L of the line

portion 3-1 and the line width of the line width 3-2

are supposed to be equal).

15   Then, at the Step ST.4, the relationship between

the space width and the shortening amount of the line

portion is obtained experimentally or by simulation.

When this relationship is obtained experimentally, a

measurement pattern with a pattern shown in FIG. 7D is

20   formed on a wafer, and a shortening amount can be

measured using a scanning electron microscope (SEM) or

electric measurement. When obtained by simulation, a

measurement pattern shown in FIG. 7D is reproduced on a

manufacturing process simulator to calculate the

25   shortening amount.

Then, at the Step ST.5, a correction rule is

established for the space width to the adjoining line

portion using the obtained relationship between the space width and the shortening amount. The relationship between the space width and the shortening amount is shown in FIGS. 7E and 7F.

5   As shown in FIGS. 7E and 7F, in one pattern example, the greater becomes the space width S as shown by the variation curve I, the larger is dislocated the shortening amount from "0", that is, the design value. That is, the greater becomes the space width S, the

10   thinner becomes the line width L. Based on such trends, in the third preferred embodiment, a correction rule is established so that the width of the above contact portion 3-c gets larger as the space width S becomes larger compared to the above side 7 in contact.

15   Then, at the Step ST.6, a correction rule table is made based on the above correction rule. To do this, as shown in FIGS. 7E and 7F, the vertical axis (shortening amount) is first divided per design grid width W (the design grid width W is, for example, the

20   minimum width which can be added at one time on CAD). Next, an intersection between the design grid width W and the variation curve I is extracted. The intersections obtained through this work are "a," "b," and "c." Then, the correction value is set at "0" for

25   the range of the space width S of "S < a," while the correction value of "+W" is provided for the range of the space width S of "a ≦ S < b." Moreover, the

correction value of "+2W" is provided for the range of the space width S of "b $\leq$ S < c," and the correction value of "+3W" for the range of the space width S of "c $\leq$ S." By this work, a correction rule table as shown in FIG. 7G is made.

Moreover, at the Step ST.6, correction values for the space width S obtained at the Step ST.3 are extracted from the correction rule table so made.

Then, at the Step ST.7, the extracted correction values are added as a fringe amount to the above side 7 in contact. This fringe processing can be automatically executed by making a correction tool adapted to the present invention through programming, storing it in CAD, for example, and using it appropriately. A pattern example of the state where the fringe processing is completed is shown in FIG. 7H. As shown in FIG. 7H, the above side 7 in contact is provided with a fringe 8.

According to the third preferred embodiment, as with the first and the second preferred embodiments, a correction fringe amount is obtained considering the surrounding environment such as pattern density, its line width, etc. for the side 7 in contact where the contact portion 3-c is in contact with the enlarged contact portion 6, and a correction rule table is made. After that, fringe processing is executed automatically using the correction tool according to the correction

rule table.

In a pattern formed by a wafer process using a mask for manufacturing semiconductor to which such fringe processing is given, the above overlapped portion can be finished in the state closer to the design value or according to the design value in comparison to the case where a mask to which uniform fringe processing is given regardless of the surrounding environment.

In this way, as the above overlapped portion can be finished in the state closer to the design value, a problem such as a rise in contact resistance caused by reduction in a contact area or the like, for example, can be avoided. Thus, in a formed integrated circuit, a contact resistance closer to the design value can be obtained, and expected electric performance can be gained easily on circuits.

The difference between an example (FIG. 7E) and another example (FIG. 7F) of the correction rule is that the correction value is incremented by W with the shortening amount "0" as reference or that the correction value is incremented by "W" with the value of the shortening amount "0" plus 1/2 of the design grid width "W" as reference. In either example, a pattern formed on the wafer can be finished in the state close to the design value or according to the design value.

However, another example that the correction value is incremented by "+W" with the value plus 1/2 of the design grid width as reference shown in FIG. 7F is finished much closer to the design value or according to the design value.

That is because in the example shown in FIG. 7E, when "S < c", for example, the variation of the line width L can be kept to the variation within the range from the shortening amount "0" (that is, design value) to "-W," while another example shown in FIG. 7F can further keep the variation to the range from the line width variation amount "0" (that is, design value) to the range of "±W/2."

Also, as shown in FIG. 7H, in the pattern according to the above one example, correction was made by adding the fringe 8 to the line portion 3-1 with the line width L, but when there is a line width other than the line width L, a correction rule is established with the same method as above for each line width, and a correction rule table is made according to this correction rule. After that, correction of adding fringes may be made based on the established correction rule table.

(Fourth preferred embodiment)

Next, a mask pattern correcting method according to a fourth preferred embodiment of the present invention will be described.

The fourth preferred embodiment is fringe processing correcting shortening, considering an area which is a gate end and not within a transistor portion in an end part of the line running on the transistor portion.

FIG. 8 is a flowchart sowing a mask pattern correcting method according to the fourth preferred embodiment, FIGS. 9A through 9E are diagrams for explaining steps shown in FIG. 8.

First, at the Step ST.1, a portion that is a gate end and not on a transistor portion of the end part of the line running on the transistor portion is extracted. In FIG. 9A, one example of the pattern used for the fourth preferred embodiment is shown. This example is on design, for example, on CAD data, and a portion 9 shown by shading in FIG. 9A is the gate end and not on the transistor portion.

Then, at the Step ST.2, an area A of the above portion 9 is measured on design, for example, on CAD data.

Next, at the Step ST.3, a shortening amount of the line portion is obtained per area A experimentally or by simulation. This shortening amount can be measured using a scanning electron microscope (SEM) or electric measurement as with the first to the third preferred embodiments.

Then, at the Step ST.4, a correction rule for the above area A is established. The relationship between

the area and the shortening amount is shown in FIGS. 9B and 9C.

As shown in FIGS. 9B and 9C, in one pattern example, the smaller is the area A as shown by the variation curve I, the larger is dislocated the shortening amount from "0", that is, the design value. That is, the smaller is the area A, the thinner becomes the line width L. Based on such trends, in the fourth preferred embodiment, a correction rule to correct a pattern is established so that the area of the above portion 9 gets larger as the area A becomes smaller compared to the above portion.

Then, at the Step ST.5, a correction rule table is made based on the above correction rule. To do this, as shown in FIGS. 9B and 9C, the vertical axis (shortening amount) is first divided per design grid width W (the design grid width W is, for example, the minimum width which can be added at one time on CAD). Next, an intersection between the design grid width W and the variation curve I is extracted. The intersections obtained through this work are "a," "b," and "c." Then, the correction value of "+3W" is provided for the range of the area A of "A < a," "+2W" for the range of "a $\leqq$ A < b," and "+W" for the range of "b $\leqq$ A < c." Also, the correction value is not provided for the range of the area A of "c $\leqq$ A." By this work, a correction rule table as shown in FIG. 9D is made.

Moreover, at the Step ST. 5, correction values for the area A obtained at the Step ST.2 are extracted from the correction rule table so made.

Then, at the Step ST.6, the extracted correction values are added to the line end of the above portion 9 as a fringe amount. This fringe processing can be automatically executed by making a correction tool adapted to the present invention through programming, storing it in CAD, for example, and using it appropriately. A pattern example of the state where the fringe processing is completed is shown in FIG. 9E. As shown in FIG. 9E, the above portion 9 is provided with a fringe 10.

According to this fourth preferred embodiment, a correction amount is obtained for the area of the portion 9 which is a gate end and not on a transistor portion and made into a correction rule table. After that, fringe processing is executed automatically using the correction tool according to the correction rule table.

In a pattern made by the wafer process using a mask for manufacturing a semiconductor device on which such fringe processing is given, in comparison to the case where a mask is used to which a uniform fringe processing is given regardless of the surrounding environment, the above portion 9 can be finished in the state closer to the design value or according to the

design value.

In this way, as the above portion 9 is finished in the state closer to the design value, a problem such as short-circuit between a source and a drain caused by shortening of a gate can be avoided.

Also, the difference between an example (FIG. 9B) and another example (FIG. 9C) of the correction rule is that the correction value is incremented by "W" with the shortening amount "0" as reference or that the correction value is incremented by "W" with the value of the shortening amount "0" plus 1/2 of the design grid width W as reference. In either example, a pattern formed on the wafer can be finished in the state close to the design value or according to the design value.

However, another example that the correction value is incremented by "+W" with the value plus 1/2 of the design grid width as reference shown in FIG. 9C is finished much closer to the design value or according to the design value.

That is because in one example shown in FIG. 9B, when "S < c," the variation of the line width L can be kept to the variation within the range from the shortening amount "0" (that is, design value) to "-W," while another example shown in FIG. 9C can further keep the variation to the range from the line width variation amount "0" (that is, design value) to the

range of "$\pm W/2$."

(Fifth preferred embodiment)

Next, a mask pattern correcting method according to a fifth preferred embodiment of the present invention will be described.

The fifth preferred embodiment is notch processing, considering the distance between a corner portion and a line portion adjoining this corner portion in the corner portion of a transistor portion. Here, the notch processing is defined as cutting of the corner portion of the transistor portion for proximity effect correction.

FIG. 10 is a flowchart sowing a mask pattern correcting method according to the fifth preferred embodiment, FIGS. 11A through 11F are diagrams for explaining steps shown in FIG. 10.

First, at the Step ST.1 shown in FIG. 10, a corner portion of a transistor portion is extracted. In FIG. 11A, one example of the pattern used for the fifth preferred embodiment is shown. This example is on design, for example, on CAD data, and the portion referred to by the reference number 11 in FIG. 9A is the corner portion and the portion referred to by the reference number 12 is the line portion.

Next, at the Step ST.2, the distance S from the corner portion 11 to the line portion 12 is measured on design, for example, on CAD data.

Then, at the Step ST.3, the minimum distance d that the line portion 12 does not overlap rounding of the corner portion 11 is obtained experimentally or by simulation.

5   Next at the Step ST.4, a correction rule is established for the above distance S. In FIG. 11B, the relationship between the rounding 13 of the corner portion 11 and the line potion 12 is shown. As shown in FIG. 11B, if the above distance S is above the

10   minimum distance d (S $\geq$ d), the line portion 12 does not overlap the rounding of the corner portion 11, but if the above distance S is less than the minimum distance d (S < d), it overlaps the rounding. Based on such trends, in the fifth preferred

15   embodiment, if "S < d," notch processing is given to the corner portion 11, while if "S $\geq$ d," notch processing is not given to the corner portion 11. Such a correction rule is made into a table in FIG. 11C.

20   Then, at the Step ST.6, the notch processing is given to the corner portion 11 when required according to the above correction rule. This notch processing can be automatically executed by making a correction tool adapted to the present invention through

25   programming, storing it in CAD, for example, and using it appropriately.

The pattern examples to which notch processing is

given are shown in FIGS. 11D, 11E and 11F. As shown in FIGS. 11D to 11F, the corner portion 11 is provided with a notch portion 14.

According to this fifth preferred embodiment,
5   notch processing is given to the corner portion 11 of the transistor portion, considering the distance S between this corner portion 11 and the line portion 12.

In a pattern formed by a wafer process using a mask for manufacturing semiconductor to which such
10   notch processing is given, the line portion 12 does not overlap the rounding of the corner portion 11. As a result, even if shortening occurs at the line portion 12, the transistor portion will not be exposed easily. Thus, a problem such as short-circuit between a source
15   and a drain caused by shortening of the line portion 12 (gate) can be avoided.

(Sixth preferred embodiment)

Next, a mask pattern correcting method according to a sixth preferred embodiment of the present
20   invention will be explained.

The sixth preferred embodiment is bias processing for a deep contact hole in contact with the transistor portion or a shallow contact hole in contact with the gate when the side wall of the contact hole is not
25   vertical.

FIG. 12 is a flowchart showing a mask pattern correcting method according to the sixth preferred

embodiment, FIGS. 13A to 13G are diagrams for explaining steps shown in FIG. 12.

First, at the Step ST.1 shown in FIG. 12, a contact portion between the contact hole and the transistor portion and a contact portion between the contact hole and the gate are extracted. FIG. 13A shows an example of the pattern used for the sixth preferred embodiment (cross sectional example). In FIG. 13A, the portion referred to by the reference number 15 is the contact portion of the contact hole and the transistor portion and the portion referred to by the reference number 16 is the contact portion of the contact hole and the gate.

Then, at the Step ST.2, a diameter S1 of the contact portion 15 for the design dimension and a diameter S2 of the contact area 16 for the design dimension are obtained experimentally or by simulation. Here, the diameters S1 and S2 can be obtained by using methods such as scanning electron microscope (SEM) or electric measurement.

Next, at the Step ST.3, the difference between the diameter S1 and the diameter S2, "S1 - S2" is obtained.

Then, at the Step ST.4, a vertical axis of the FIG. 13B or 13C (the difference between the diameter S1 and the diameter S2, "S1 - S2") is divided per design grid width W with the point of "S1 - S2 = 0" as reference (FIG. 13B) or the point of "S1 - S2 = 0"

plus 1/2 of the design grid width W as reference

(FIG. 13C). Then, an intersection between the straight

line showing the design grid width W and the S1 - S2

curve is extracted. When the intersections extracted

5 by the above work for a gate film thickness L are "a,"

"b," and "c," a bias amount to be added to the diameter

S1 in the range of "design dimension < a" is "0," a

bias amount of "+W" is added to the diameter S1 in the

range of "a $\leqq$ design dimension < b," a bias amount of

10 "+W" is added to the diameter S1 in the range of "b $\leqq$

design dimension < c," and a bias amount of "+2W" is

added to the diameter S1 in the range of "c $\leqq$ design

dimension." By this work, a correction rule table as

shown in FIG. 13D is made for a gate film thickness L.

15 by correcting the diameter S1 according to the

correction rule table shown in FIG. 13D, the diameter

S1 gets closer to the diameter S2.

  Also, contrary to the above work, the diameter S2

can be made closer to the diameter S1 by subtracting a

20 bias amount from the diameter S2. The correction rule

table made by this method is shown in FIG. 13E. Then,

correction values for the diameter S1 obtained at the

Step ST.2 or the diameter S2 are extracted from the

correction rule table so made.

25 Next, at the Step ST.5, the extracted correction

values are added to the contact hole as a bias amount.

This bias processing can be automatically executed by

making a correction tool adapted to the present
invention through programming, storing it in CAD, for
example, and using it appropriately. The cross section
of the state where the bias processing is completed is

5   shown in FIGS. 13F and 13G. As shown in FIG. 13F, the
diameter S1 of the contact portion 15 is enlarged so
that it is almost equal to the diameter S2 of the
contact portion 16. Also, as shown in FIG. 13G, the
diameter S2 of the contact portion 16 is reduced so

10   that it is almost equal to the diameter S1 of the
contact portion 15.

According to this six preferred embodiment, when
the diameter S1 of the contact portion 15 in contact
with the transistor portion is different from the

15   diameter S2 of the contact portion 16 in contact with
the gate, the diameter S1 can be made the same as the
diameter S2, and the diameter S1 and the diameter S2
·can be finished in the state close to the design value.

As the diameter S1 and the diameter S2 can be

20   finished in the state closer to the design value, a
problem such as a rise in contact resistance caused by
reduction in a contact area or the like can be avoided.
Thus, in a formed integrated circuit, a contact
resistance closer to the design value can be obtained,

25   and expected electric performance can be gained easily
on circuits.

The difference between an example (FIG. 13B) and

another example (FIG. 13C) of the correction rule is
that the correction value is incremented by "W" with
"S1 - S2 = 0" as reference or that the correction value
is incremented by "W" with "S1 - S2 = 0" plus 1/2 of

5   the design grid width W as reference. In either
example, a pattern formed on the wafer can be finished
in the state close to the design value or according to
the design value.

However, another example that the correction value

10   is incremented by "+W" with the value plus 1/2 of the
design grid width as reference shown in FIG. 13C is
finished much closer to the design value or according
to the design value.

That is because in one example shown in FIG. 13B,

15   the variation of "S1 - S2" when "design dimension < c,"
can be kept to the variation within the range from
"S1 - S2 = 0 (that is, design value)" to "-W," while
another example shown in FIG. 13C can further keep the
variation to the range from "S1 - S2 = 0 (that is,

20   design value) to the range of "±W/2."

Also, as shown in FIG. 13F or FIG. 13G, in the
pattern according to the above example, bias processing
is made for the gate film thickness L, but when there
is a film thickness other than the gate film thickness

25   L, a correction rule can be made for each film
thickness with the method as above, and a correction
rule table is made according to this correction rule.

After that, bias processing can be made for each line
width based on the correction rule table so made.
(Seventh preferred embodiment)

Next, a mask pattern correcting method according
5   to a seventh preferred embodiment of the present
invention will be explained.

The seventh preferred embodiment is fringe
processing at a line end for each via in contact with
both ends of the line form above and below.

10   FIG. 14 is a flowchart showing a mask pattern
correcting method according to the seventh preferred
embodiment, and FIGS. 15A to 15H are diagrams for
explaining steps shown in FIG. 14.

First, at the Step ST.1 shown in FIG. 14, a
15   contact portion between a via 1 and a line portion 17
and a contact portion between a via 2 and a line
portion 17 are extracted. FIG. 15A shows one example
(cross section) of the pattern used for the seventh
preferred embodiment.

20   Then, at the Step ST.2, using the method explained
for the second preferred embodiment, fringe processing
to the via 1 and the end of the line portion 17 in
contact with this via 1 is made into a correction rule
(FIG. 15B or 15C).

25   Then, at the Step ST.3, using the method explained
for the second preferred embodiment, a correction rule
table is made according to the above correction rule

(FIG. 15D). After that, correction values are
extracted from the correction rule table so made.

Next, at the Step ST.4, a distance D from the
portion where the via 2 is in contact with the portion
5   to the end of the line portion 17 is obtained
experimentally or by simulation.

Then, at the Step ST.5, using the method explained
for the second preferred embodiment, fringe processing
to the end of the line portion 17 in contact with
10   the via 2 is made into a correction rule (FIG. 15F
or 15G).

Then, at the Step ST. 6, a correction rule table
is made with the point of "shortening amount = -D" as
reference (FIG. 15E) or with the point of "shortening
15   amount = -D" plus 1/2 of the design grid width W as
reference (FIG. 15F) (FIG. 15G). After that,
correction values are extracted from the correction
rule table so made.

Next, at the Step ST.7, the extracted correction
20   values are added to the contact portion between the via
1 and the line portion 17 and the contact portion 19
between the via 2 and the line portion 17 as a fringe
amount. This fringe processing can be automatically
executed by making a correction tool adapted to the
25   present invention through programming, storing it
in CAD, for example, and using it appropriately.
A pattern example of the state where the fringe

processing is completed is shown in FIG. 15H. As shown in FIG. 15H, the contact portions 18 and 19 of the line portion 17 are provided with fringes 20-1 and 20-2, respectively.

5   According to this seventh preferred embodiment, fringe to correct shortening of the line portion 17 for the contact portions 18 and 19 of the line portion 17 is added, considering the environment surrounding the line portion 17 such as pattern density around the line 10   portion 17, width of the line portion, thinning of the via, etc.

    In a pattern made by the wafer process using a mask for manufacturing a semiconductor device on which such fringe processing is given, in comparison to the 15   case where a mask is used to which a uniform fringe processing is given regardless of the surrounding environment, the above overlapped portion can be finished in the state closer to the design value or according to the design value.

20   In this way, as the above overlapped portion is finished in the state closer to the design value, a problem such as a rise in contact resistance caused by reduction in a contact area or the like can be avoided. Thus, in a formed integrated circuit, a contact 25   resistance closer to the design value can be obtained, and expected electric performance can be gained easily on circuits.

Also, the difference between an example (FIG. 15B, FIG. 15E) and another example (FIG. 15C, FIG. 15F) of the correction rule is that the correction value is incremented by "W" with the shortening amount "0 - D" as reference or that the correction value is incremented by "W" with the value of the shortening amount "0 - D" plus 1/2 of the design grid width W as reference. In either example, a pattern formed on the wafer can be finished in the state close to the design value or according to the design value.

However, another example that the correction value is incremented by "+W" with the value plus 1/2 of the design grid width as reference shown in FIG. 15C is finished much closer to the design value or according to the design value.

That is because in one example shown in FIGS. 15B and 15E, when "S < c," the variation of the line width L can be kept to the variation within the range from the shortening amount "0 - D" (that is, design value) to "-W," while another example shown in FIGS. 15C and 15F can further keep the variation to the range from the line width variation amount "0 - D" (that is, design value) to the range of "±W/2."

Also, as shown in FIG. 15H, in the pattern according to the above example, correction to add the fringes 20-1 and 20-2 is made to the line portion 17 with the line width L, but when there is a line width

other than the line width L, a correction rule is made with the same method as above for each line width, and a correction rule table is made according to this correction rule. After that, the correction to add

5 fringes may be made for each line width based on the correction rule table so made.

(Eighth preferred embodiment)

Next, a mask pattern correcting method according to a eighth preferred embodiment of the present

10 invention will be explained.

The eighth preferred embodiment is a correcting method, further considering misalignment in addition to the first to the fifth preferred embodiments and the seventh preferred embodiment.

15 FIG. 16 is a flowchart showing a mask pattern correcting method according to the eighth preferred embodiment.

First, at the Step 1 shown in FIG. 16, a correction rule table is made for each of the

20 correcting methods by the first to the fifth preferred embodiments and the seventh preferred embodiment.

Then, at the Step ST.2, a misalignment amount is set at "+C." Then, the misalignment amount "+C" is added to fringe amount of each correction rule table

25 and the corrected points. By this wora k, the correction rule table shown in FIG. 17A can be made from the first, second, third, and seventh preferred

embodiments, the correction rule table shown in

FIG. 17B from the fourth preferred embodiment, ad the

correction rule table shown in FIG. 17C from the fifth

preferred embodiment.

5   Next, as shown at the Step ST. 3, correction

values are extracted from the rule table so made and

the extracted correction values are added to the fringe

amount.

According to this eighth preferred embodiment,

10   correction values considering misalignment for the

first to the fifth preferred embodiments and the

seventh preferred embodiment are made into a correction

rule. And according to this correction rule,

correction processing is done automatically using the

15   correction tool. By this correction processing, even

in the case of dislocation of the desired dimension due

to proximity effect and misalignment, corrected points

can be finished according to the design value or close

to the design value.

20   (Ninth preferred embodiment)

Next, a mask pattern correcting method according

to a ninth preferred embodiment of the present

invention will be explained.

The ninth preferred embodiment is correction of

25   short-circuit of the narrow space width, considering

the distance between the portion where the contact and

the transistor portions overlap each other and the

transistor portion end for the narrow space width of
the transistor.

FIG. 18 is a flowchart showing a mask pattern
correcting method according to the ninth preferred
5   embodiment. FIGS. 19A to 19F are diagrams for
explaining steps shown in FIG. 18.

At the Step ST.1 shown in FIG. 18, the portion
where the contact portion overlaps the transistor
portion is extracted. An example of the pattern used
10   for the ninth preferred embodiment is shown in FIG. 19A
and another pattern in FIG. 19B. The example shown in
FIG. 19A and another example in FIG. 19B are on design,
for example, on CAD data.

As shown in FIG. 19A, the pattern according to the
15   example has transistor portions 22 and 23 separated
from each other by a field portion (element separating
portion) 21. The transistor portion 22 overlaps
contact portions 24-1 and 24-2, while the transistor
portion 23 overlaps contact portions 24-3 and 24-4,
20   respectively.

The pattern according to another example shown in
FIG. 19B is similar to the pattern according to the
example, except the distance from the contact portions
24-2 through 24-2 to the transistor portion end 25.

25   Then, at the Step ST.2, a narrow space width S is
measured on design. Next, the distance from the
transistor portion end 25 to the contact portions 24-1

through 24-4 is measured on design. The minimum
distance at this time is set as "F."

Then, as shown at the Step ST.3, the minimum bias
amount and the minimum misalignment amount for the
5   contact portions 24-1 through 24-4 are obtained
experimentally or by simulation, and the sum of the
bias amount and the misalignment amount at this time is
set as "D." From this result, the contact portion is
enlarged by the minimum design rule of the fringe
10   amount.   The enlarged contact portion is referred to by
the reference number 26.

Next, as shown at the Step ST.4, in the case of
"D $\leq$ F" and "F < D," respectively, a correction value
to enlarge the narrow space width by the size of the
15   narrow space width S is obtained experimentally or by
simulation, and a correction rule is established
(FIG. 19C).

Then as shown at the Step ST.5, a correction rule
table is made according to the above correction rule,
20   and correction values are extracted (FIG. 19D).   Here,
when "F < D," the portion where the enlarged contact
portion 26 is in contact with the transistor portion
end 25 is extracted.   This contact portion is referred
to by the reference number 27 in FIG. 19B.

25   Then, as shown at the Step ST.6, the extracted
correction values are added to the narrow space width
S.   Here, when "D $\leq$ F," the entire narrow space width S

is enlarged toward the transistor portions 22 and 23 as shown in FIG. 19F. Also, in the case of "F < D," as shown in FIG. 19F, the narrow space width S is enlarged toward the transistor portions 22 and 23 except the

5   above portion 27 in contact.

According to this ninth preferred embodiment, by the sum of the bias amount and the misalignment amount of the contact portion, the minimum distance from the transistor portion end 25 to the contact portion, and

10   the narrow space width S, the correction amount of the narrow space width portion is made into a correction rule table. Then, according to the correction rule table, narrow space width correction processing is made automatically using a correction tool. With such

15   correction processing, short-circuit in the narrow space width can be prevented.

The prevent invention has been described above based on the first to the ninth preferred embodiments, but the present invention is not limited to the first

20   to the ninth preferred embodiments and can be implemented with various variations without deviating from the subject matter of the invention.

For example, the mask pattern correcting method described in the preferred embodiment can be applied to

25   CAD as a program which can be carried out by a computer by writing in a magnetic disk (floppy disk, hard disk, etc.), optical disk (CD-ROM, CD-RAM, DVD, etc.),

semiconductor memory, etc. or can be applied to CAD by transmitting on a communication medium. Also, the CAD to implement the present invention carries out the above mask pattern correction processing by reading the

5   program recorded in the recording medium and controlling operation by this program.

Also, the present invention can be applied to any semiconductor integrated circuit device but is especially effective for logic integrated circuit

10   device with random pattern such as microprocessors as an example.

Also, the present invention can be implemented with various variations without deviating from the subject matter of the present invention.

15   As mentioned above, according to the present invention, a pattern correcting method of a mask for manufacturing a semiconductor device which can consider pattern relationship of finishing error and obtain sufficient correction accuracy.

20   Additional advantages and modifications will readily occur to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details and representative embodiments shown and described herein. Accordingly, various

25   modifications may be made without departing from the spirit or scope of the general inventive concept as defined by the appended claims and their equivalents.